

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



**FOR
HEATING, VENTILATION, AIR
CONDITIONING/REFRIGERATION (HVAC/R)
(3E1X1)**

**MODULE 13
WELDING & CUTTING**

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Career Field Education and Training Plan (CFETP) references from 1 July 2002 version.

OPR: HQ AFCESA/CEOF
(SMSgt Dan Sacks)
Supersedes AFQTP 3E1X1-13, 30 Jun 00

Certified by: HQ AFCESA/CEOF
(CMSgt Myrl F. Kibbe)
Pages: 14/Distribution F

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INTRODUCTION

Before starting this AFQTP, refer to and read the “[AFQTP TRAINER/TRAINEE GUIDE](#).”

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP **does not** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

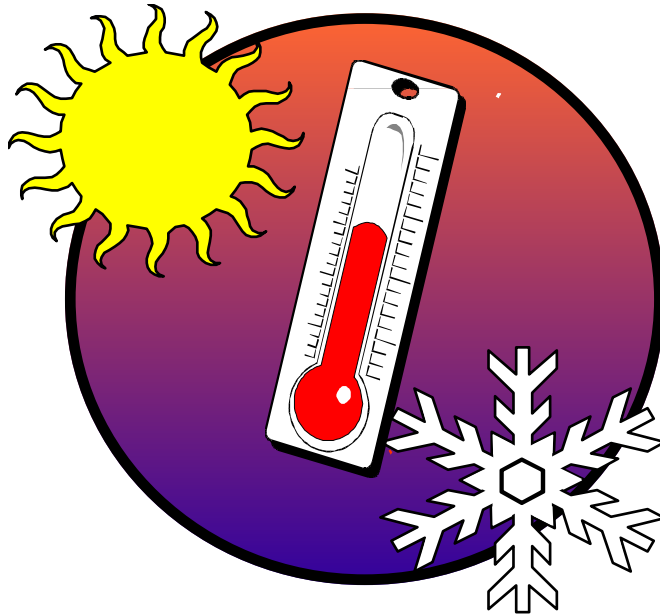
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts, under the direction and guidance of HQ AFCESA/CEOF, revised this AFQTP. If you have any recommendations for improving this document, please contact the HVAC/R Career Field Manager at the address below.

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WELDING AND CUTTING

USE EQUIPMENT

MODULE 13

AFQTP UNIT 2

BRAZE AND SOLDER (13.2.2.)

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BRAZE AND SOLDER

Task Training Guide

STS Reference Number/Title:	13.2.2. - Braze and Solder.
Training References:	<ol style="list-style-type: none"> 1. <u>Technical Order (TO) 42D-1-3, Method of Identifying Steel, Aluminum and Copper Alloys in Air Force Stock.</u> 2. <u>TO 34W4-1-8, Use of Welding, Brazing, and Silver Soldering Electrodes, Rods, and Wire.</u> 3. <u>TO 34W4-1-5, Operator's Manual, Welding Theory and Application.</u> 4. <u>Air Force Occupational Safety and Health Standard (AFOSHSTD) 91-5, Welding, Cutting, and Brazing.</u> 5. Career Development Course (CDC) HVAC/R Journeyman 3E151D, Volume 2, Section 3; <i>Oxyacetylene Equipment Familiarization and Utilization.</i>
Prerequisites:	<ol style="list-style-type: none"> 1. Possess a minimum of a 3E131 AFSC. 2. Review the following references: <ol style="list-style-type: none"> 2.1. TOs 42D-1-3, 34W4-1-5, and 34W4-1-8. 2.2. AFOSHSTD 91-5. 2.3. CDC HVAC/R Journeyman 3E151D, Volume 2, Unit 3.
Equipment/Tools Required:	<ol style="list-style-type: none"> 1. Personal safety equipment. 2. Oxyacetylene rig. 3. Hydrocarbon torch. 4. Two ½" x 6" sections of copper tubing. 5. Two ½" copper elbows. 6. Flux. 7. Acid brush. 8. Silver solder. 9. Soft solder. 10. Emory cloth. 11. Wet rags. 12. Striker. 13. Pliers. 14. Table vise. 15. Fire extinguisher. 16. AF Form 592, Welding, Cutting, and Brazing Permit (or perform in area with standing permit).
Learning Objective:	The trainee will know the steps required to safely braze and solder.
Samples of Behavior:	Trainee will braze and solder fittings to copper tubing.
Notes:	
<ol style="list-style-type: none"> 1. To successfully complete this element follow the steps outlined 2. Trainer must develop a training scenario to braze and soldering copper. 3. Any safety violation is an automatic failure. 	

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BRAZE AND SOLDER

1. Background. Throughout your career as an HVAC/R mechanic you will be tasked with installing or repairing different types of piping systems. In this unit we will be discussing the most widely used system: copper tubing. Copper tubing and its associated fittings are used in the installation or repair of an HVAC/R system. Depending on the installation and its requirements the two methods used to connect copper tubing and fitting together is soft soldering and silver brazing.

2. Soft Soldering Copper Joints. Soft soldering is a method of joining two metals together by allowing molten solders to run between the copper and fittings. The copper must be cut to length, reamed, and cleaned before you are ready to solder the joints. The most common equipment is the air-acetylene torch commonly known as the hydrocarbon torch.

2.1. Hydrocarbon Torch. For soft solder, use the hydrocarbon torch. The hydrocarbon torch consists of a tank, tank valve, pressure regulator, hose, torch handle, and tips. The tank contains the acetylene (fuel). When you open the tank valve, the acetylene is admitted to the regulator and to the tank pressure gauge. The regulator regulates the amount of pressure to the torch when you adjust the regulator knob.

CAUTION:

DO NOT USE ACETYLENE AT PRESSURE ABOVE 15 PSI; TO DO SO MAY CAUSE AN EXPLOSION). THE TIPS MAY BE CHANGED TO COMPENSATE FOR THE VARIOUS APPLICATIONS WHERE MORE OR LESS HEAT IS REQUIRED.

2.2. Joint Preparation. Your preparation of joints for soft soldering must be thorough. Metal surfaces must be perfectly clean at the joint to obtain a good bond between the base metal and the solder. You must remove all dirt, grease, oil, paint, etc., and make the metal bright. Clean the copper with a wire brush, file, emery cloth, steel wool, or use chemical cleaners. After the inside of the fitting and the outside end of the copper are cleaned, flux them to prevent oxidation. Put the fitting into position and prepare to heat the joint. Fifty-fifty solder (50-percent lead and 50-percent tin) is best for soft soldering on wastewater lines. However, a solder with 95 percent tin and 5 percent antimony known as 95/5, is specially designed for refrigeration work and potable water.

2.3. Assembling the Joint. When the fitting and copper are ready to be joined, apply the tip of the flame around the fitting. Do this by moving the flame back and forth. This procedure keeps the flame from overheating the tube and fitting.

2.3.1. An overheated joint causes the solder to seep through the joint and flow away. Therefore occasionally test the heat by touching the fitting with solder where the copper and fitting join. Normally, thick wall-fittings require more heat than thin wall-fittings. When the tube and fitting melt the solder, the sweating may begin.

2.3.2. When the connection is hot enough to melt the solder, remove the flame and apply the solder to the edge of the fitting where it comes into contact with the tube. Solder, when confined between two surfaces, will run uphill by capillary attraction. Therefore, joints can be made in any position.

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2.3.3. When a line of solder shows up around the fitting—that is, when a bead of solder appears in the groove at the end of the fitting—the joint has all the solder it will take. When applying solder to a tee, feed solder from both ends of the fitting. Reheat the fitting slightly to help the solder penetrate into the metal. Remove the flame and continue to feed the solder to make sure the joint is filled.

2.3.4. Allow the joint to cool for a short while. A rag saturated with water will hasten this cooling. When cooling male and female adapters, allow more time for the solder to set. Because these fittings are heavier, they hold heat longer, and they do not cool as quickly.

3. Silver Soldering Copper Joints. Silver soldering requires a lot more heat than soft solder. This type of solder is normally used to braze different metals together, or when the tubing must transport at high pressure.

3.1. Oxyacetylene Torch. Because of the additional heat required, use the oxyacetylene torch. Refer to CDC 3E151D, Volume 2, Unit 3, Section 3-1, *Oxyacetylene Equipment*, if you need to brush up or find information on how to operate an oxyacetylene torch.

3.2. Joint preparation. A clean, oxide-free surface is needed to ensure uniform quality and a sound soldered joint. Remove all grease, oil, dirt, and oxides from the base metal and the filler rod to obtain uniform capillary attraction throughout the joint.

3.3. Flux. Flux serves various purposes in making strong, uniform soldered joints. A good flux will react chemically with surface films, cleaning the metal surfaces to receive the molten silver alloy. It also forms a protective film during the soldering cycle, and allows the silver alloys to flow freely. Using flux does not eliminate the need for cleaning the parts before silver soldering. It comes in a variety of forms, such as powder, paste, liquid, and solid. Remove excess flux after you complete the soldering.

3.4. Technique. For silver soldering, adjust the torch flame to neutral. Do not let the inner core of the flame touch the metal, since this can cause the filler metal to be sluggish at the flow point and the flux to burn. Keep the torch in motion all the time it is in use. Holding it in one place too long can easily overheat the base metal and the flux. For large surfaces or thick metals, preheat the metal well away from the joint, especially if you are soldering metals with high heat conductivity. Be careful in soldering metals of unequal thickness or unequal heat conductivity because all metal parts should reach the soldering temperature at the same time.

NOTE TO TRAINER/CERTIFIER:

For this task provide the trainee with two pieces of ½" x 6" copper tubing and two ½" copper elbows. Have the trainee soft solder a copper joint using a hydrocarbon torch and braze a copper joint using an oxyacetylene torch.

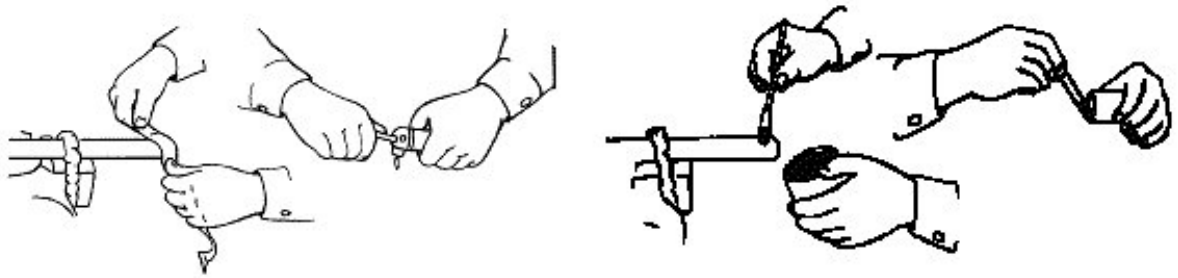
4. Procedures. Follow these steps to perform the following tasks:

4.1. Soft Soldering Copper Joint with Hydrocarbon Torch.

Step 1: Coat the pieces to be soldered with flux after all dirt, oil, grease, and oxides have been removed. (Figure 2-1.)

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Figure 2-1. Cleaning and Fluxing Tubing and Fitting.



Step 2: After fittings have been fluxed, slide tubing into fittings.

Step 3: Place tubing in table vise with the end out for soldering.

Step 4: Heat fitting.

- 4.1. Apply heat evenly around the fitting.
- 4.2. Do this by moving the flame back and forth.
- 4.3. This procedure keeps from over heating the tube fitting or burning out the flux.
- 4.4. When soldering small diameter tubing apply the heat to one area of the fitting.

Step 5: Solder joint.

- 5.1. Touch the solder to the fitting while applying heat.
- 5.2. As soon as the connection is hot enough to melt the solder, remove the flame and apply the solder to the edge of the fitting.
- 5.3. The solder will then be drawn into the fitting by capillary action.
- 5.4. When a bead of solder appears at the edge of the fitting the joint has all the solder it will take.

HINT:

Applying flux to the fitting prior to cooling the joint will remove some of the excess solder.

Step 6: Allow the joint to cool. Use a wet rag to help cool the joint.

Step 7: Remove excess solder. Remove excess solder with a small brush or fine emery cloth.

Step 8: Clean area and place tools in proper areas.

4.2. Silver Soldering (Brazing) Copper Joint with Oxyacetylene Torch.

Step 1: Remove all dirt, grease, oil, and oxides from the surfaces to be brazed.

Step 2: Select the correct flux and apply it to both the work and filler metal.

Step 3: Assembly the pieces and place them in the table vise.

Step 4: Preheat the entire work by playing the torch over the surfaces to bring them up to a uniform brazing temperature.

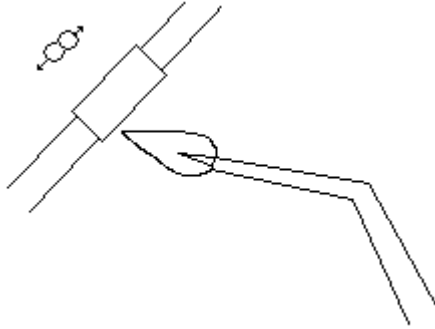
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Step 5: As soon as the flux is completely fluid, touch the filler metal to the joint. (DO NOT LIFT FLAME).

5.1. Keep apply filler metal until it flows completely through the joint.

5.2. DO NOT apply the inner cone of the flame directly to the filler metal.

Figure 2-2. How to Apply the Flame to Joint.



Step 6: Clean the brazed work to remove all the flux residue or debris.

Step 7: Clean area and place tools in proper areas.

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**REVIEW QUESTIONS
FOR
BRAZE AND SOLDER**

QUESTION	ANSWER
1. Soft soldering is a method of joining two metals together by allowing molten solder to run between the _____ and fittings.	a. copper b. aluminum c. zinc a. iron
2. It is all right to use acetylene above 15 PSI.	a. True. b. False.
3. The _____ torch is used for soft soldering by the direct flame method, or by using a flame-heated (indirect method) soldering iron.	a. hydrocarbon b. fluorocarbon c. oxycarbon d. acetycarbon
4. In silver soldering, using flux eliminate the need for cleaning the parts.	a. True b. False.

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BRAZE AND SOLDER

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE...	YES	NO
Soft Solder with Hydrocarbon Torch		
1. assembly hydrocarbon torch outfit correctly?		
2. properly clean, flux, and assembly the joint to be solder?		
3. apply heat and solder correctly?		
4. shut down torch correctly?		
5. remove excess solder and flux correctly?		
6. successfully solder joint together?		
7. clean up area and tools?		
8. comply with all safety requirements?		
Braze with Oxyacetylene Torch		
1. assembly oxyacetylene torch outfit correctly?		
2. properly clean, flux, and assembly the joint to be braze?		
3. heat the entire work before applying filler metal?		
4. apply filler metal correctly?		
5. shut down torch correctly?		
6. remove all the flux residue or debris correctly?		
7. successfully braze the joint together?		
8. clean up area and tools?		
9. comply with all safety requirements?		

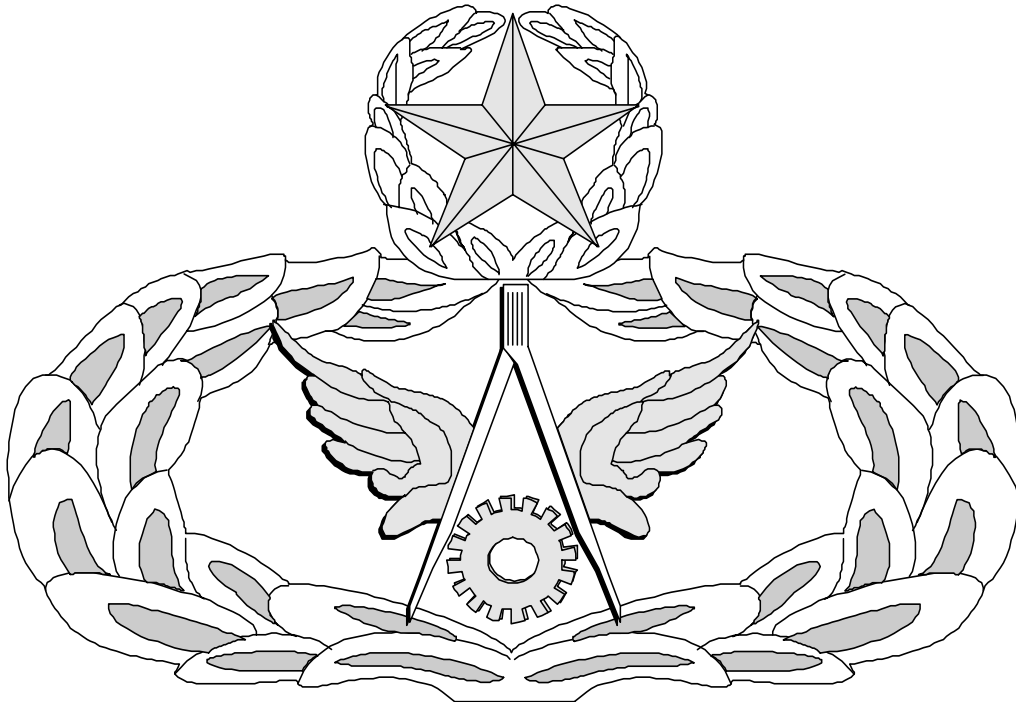
FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.

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Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



FOR
HEATING, VENTILATION, AIR
CONDITIONING/REFRIGERATION (HVAC/R)
(3E1X1)

MODULE 13

WELDING & CUTTING

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Key-1

BRAZE AND SOLDER
(3E1X1-13.2.2.)

QUESTION	ANSWER
1. Soft soldering is a method of joining two metals together by allowing molten solder to run between the _____ and fittings.	a. copper
2. It is all right to use acetylene above 15 PSI.	b. False.
3. The _____ torch is used for soft soldering by the direct flame method, or by using a flame-heated (indirect method) soldering iron.	c. hydrocarbon
4. In silver soldering, using flux eliminate the need for cleaning the parts.	b. False.

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Key-1

MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Air Force Qualification Training Package Improvement

1. Identify module.

Module # and title _____

2. Identify improvement/correction section(s)

_____ STS Task Reference	_____ Performance Checklist
_____ Training Reference	_____ Feedback
_____ Evaluation Instructions	_____ Format
_____ Performance Resources	_____ Other
_____ Steps in Task Performance	

3. Recommended changes--use a continuation sheet if necessary.

4. You may choose to call in your recommendations to DSN 523-6445 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.
5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position